

GODINA-FLORES, N.L., GUTIERREZ-GÓMEZ, Y.Y., GARCÍA-BOTELLO, M., LÓPEZ-CRUZ, L., MORENO-GARCÍA, C.F. and ACEVES-MARTINS, M. 2022. Obesity and its association with mental health among Mexican children and adolescents: systematic review. *Nutrition reviews* [online], Advanced Articles. Available from: <https://doi.org/10.1093/nutrit/nuac083>

Obesity and its association with mental health among Mexican children and adolescents: systematic review.

GODINA-FLORES, N.L., GUTIERREZ-GÓMEZ, Y.Y., GARCÍA-BOTELLO, M., LÓPEZ-CRUZ, L., MORENO-GARCÍA, C.F. and ACEVES-MARTINS, M.

2022

© The Author(s) 2022. Published by Oxford University Press on behalf of the International Life Sciences Institute.

Obesity and its association with mental health among Mexican children and adolescents: systematic review

Naara L. Godina-Flores, Yareni Yunuen Gutierrez-Gómez, Marcela García-Botello, Lizet López-Cruz, Carlos Francisco Moreno-García, and Magaly Aceves-Martins 

Context: Obesity and mental health issues increasingly affect children and adolescents, but whether obesity is a risk factor for mental health issues is unclear.

Objective: To systematically review the association between obesity and mental health issues (ie, anxiety and/or depression) among Mexican children and adolescents.

Data sourcing, extraction, and synthesis: A literature search of 13 databases and 1 search engine was conducted. Population, exposure, comparison, outcomes, and study design data were extracted, analyzed, and narratively synthesized. The JBI critical appraisal tool was used to evaluate evidence quality. **Results:** A total of 16 studies with 12 103 participants between 8 and 18 years old were included. Four studies focused on anxiety outcomes, 10 on depression, and 2 on both (ie, anxiety and depression). Evidence is unclear about the association of obesity with anxiety. However, most evidence shows that Mexican children and adolescents with overweight or obesity are more likely to have depression or report a higher number of depressive symptoms than normal-weight participants. Such likelihood is greater for females. **Conclusion:** Health promotion interventions to treat or prevent obesity could also consider mental health outcomes.

Systematic Review Registration: PROSPERO registration no. CRD42019154132

INTRODUCTION

Mental health problems and emotional disorders are increasingly prevalent, disabling, and recurrent among young people.¹ The prevalence of anxiety has been reported to be higher for children and depression higher for adolescents. However, as individuals grow, it

is more common to find both conditions (ie, anxiety and depression).² Untreated mental health issues among children and adolescents are associated with poor school performance, social functioning, and substance misuse.³ Additionally, recurring anxiety or depression can be maintained until adulthood,

Affiliation: N. L. Godina-Flores and Y. Y. Gutierrez-Gómez are with the Nutrition Department, School of Medicine and Health Sciences, Tecnológico de Monterrey, Mexico City, Mexico. M. García-Botello is with the Universidad de Monterrey, San Pedro Garza García, Nuevo León, Mexico. L. López-Cruz is with the Universidad Europea del Atlántico, Parque Científico y Tecnológico de Cantabria, Santander, Spain. C. F. Moreno-García is with the School of Computing, Robert Gordon University, Aberdeen, Scotland, UK. M. Aceves-Martins is with the The Rowett Institute of Nutrition and Health, University of Aberdeen, Aberdeen, UK.

Correspondence: M. Aceves-Martins, The Rowett Institute of Nutrition and Health, University of Aberdeen, Foresterhill, Aberdeen AB25 2ZD, UK. E-mail: magaly.aceves@abdn.ac.uk

Key words: adolescents, anxiety, children, depression, Mexico, obesity.

© The Author(s) 2022. Published by Oxford University Press on behalf of the International Life Sciences Institute.

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs licence (<https://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial reproduction and distribution of the work, in any medium, provided the original work is not altered or transformed in any way, and that the work is properly cited. For commercial re-use, please contact journals.permissions@oup.com

increasing suicide risk, which is the second leading cause of preventable death among young people.⁴

Like mental health issues, obesity is also a condition that increasingly affects children and adolescents, which can also be prolonged until adulthood and leads to various clinical conditions.⁵ Obesity and mental health disorders are closely related, and a bidirectional association between conditions has been suggested.^{6,7} Likewise, these conditions share a common etiology (eg, sedentary behaviors, altered sleep patterns, altered dietary behaviors or appetite, negative self-image) and environmental, physiological, and/or genetic factors.^{7,8} Although obesity is frequently accompanied by mental disorders, whether obesity is a risk factor for mental health issues remains unclear.^{4,6,8}

The prevalence of obesity and mental health issues has been increasing among Mexican children and adolescents in the past decades.^{9,10} It has been estimated that in Mexico, approximately 8% of infants (aged 0–4 years), 35% of children (aged 5–11 years), and almost 40% of adolescents (aged 12–19 years) have overweight or obesity.⁹ Additionally, nearly 40% of Mexican adolescents (aged 12–17 years) have 1 or more mental health disorders, with anxiety disorders most frequently reported.¹¹ There is increased recognition of a potential relationship between obesity and mental health disorders among the pediatric population.^{12,13} Several reviews evaluating the association between obesity and mental health disorders have been conducted.^{4,14–16} Nevertheless, most include only English publications, excluding valuable information from non-English-speaking low- or middle-income countries such as Mexico. Considering that both conditions (ie, obesity and mental health disorders) are highly prevalent among Mexican childhood or adolescents and the short- and long-term impact on an individual's well-being and quality of life,¹³ it is essential to acknowledge the possible associations between these conditions within the Mexican context. Furthermore, most of the current interventions to treat¹⁷ or prevent¹⁸ obesity among Mexican children or adolescents are focused merely on changing weight outcomes, overlooking the potential effect these can have on other health outcomes, such as mental health.

The “Childhood and adolescent Obesity in Mexico: evidence, challenges and opportunities” (COMO) Project^{17–21} intends to synthesize and use data to comprehend the extent, nature, effects, and costs of childhood and adolescent obesity in Mexico. This article is part of the COMO project, and in it, we aimed to systematically review the association between obesity and mental health issues (ie, anxiety and/or depression) among Mexican children and adolescents.

METHODS

The project's systematic review is registered in The International Prospective Register of Systematic Reviews (PROSPERO Registration number CRD42019154132).²² This review follows the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines.²³

Literature search

The databases searched included AGRICOLA, CAB Abstracts, CINAHL, the Cochrane Library, EMBASE, ERIC, LILACS, MEDLINE, Global Health Library PsycINFO, ScienceDirect, Scopus, and SciELO Citation Index. Also, relevant material was searched in Google Scholar. A sensitive search strategy included index terms, free-text words, abbreviations, and synonyms to combine the key concepts for this review. Terms such as “overweight,” “obesity,” “child,” “adolescent,” “depression,” “depressive disorders,” “depressive symptoms,” “anxiety,” “anxiety disorder,” and “anxiety symptoms” were included in the strategy (see [Supplemental Material 1](#) in the [Supporting Information online](#)). Whenever possible, searches were also done in Spanish to capture relevant references. In addition, the COMO project database was revised. This database comprises >950 scientific references relevant to childhood and adolescent obesity in Mexico.¹⁹ Full reports of studies and conference abstracts were included if these met the inclusion criteria. Also, reference lists of included studies were scrutinized for additional publications. English-, Spanish-, or Portuguese-language publications were considered. Reports from 1995 onward were included in this review. The original searches were done in January 2020 and updated in February 2022.

The research question and inclusion/exclusion criteria were established following the Population, Exposure, Comparison, Outcomes, Study Design (PECOS) framework ([Table 1](#)). These are described in the following paragraphs.

Population. Studies including participants from ages 0 to 18 years (mean age at the start of the study) of any ethnicity or sex living in Mexico were considered in this review. Studies that analyzed participants with diagnosed eating disorders, severe conditions (eg, HIV, cancer, Down syndrome), or pregnant adolescents were excluded.

Intervention/exposure. Studies reporting body mass index (BMI; in kg/m²) or another anthropometric measurement related to adiposity, overweight, or

Table 1 PECOS criteria for inclusion of studies

Population	Children and adolescents aged 0 to 18 years of any ethnicity or sex living in Mexico were included. Participants with diagnosed eating disorders, severe conditions, or pregnant adolescents were excluded.
Exposure	Studies reporting overweight or obesity of participants' body mass index or another anthropometric measurement related to adiposity were considered.
Comparison	Any or none
Outcomes	Studies reporting any measurement of anxiety and/or depression and/or depressive symptoms were considered.
Study design	Observational (cross-sectional or longitudinal) studies

obesity were considered in this review. For those studies reporting BMI, data had to be categorized with national or international references (eg, World Health Organization, International Obesity Task Force, Centers for Disease Control and Prevention) to be eligible.

Outcomes. Anxiety and/or depression outcomes were considered in this review. Any tool for measuring anxiety and/or depression were considered (eg, single- or multiple-item questions in a questionnaire or rating scales, standardized psychiatric interview, physician-reported diagnosis).

Study design. Cross-sectional and longitudinal studies are relevant when studying the association between childhood obesity and anxiety or depression.⁶ For this reason, human observational (cross-sectional and longitudinal) studies were considered in this review.

Data selection and extraction. After conducting the searches, titles and abstracts were examined by 3 reviewers (M.A.-M., M.G.-B., and L.L.-C.). The abstracts identified as potentially relevant for full-text review were assessed by 2 reviewers (N.L.G.-F. and M.A.-M.), and they independently extracted data from the included studies and agreed to the information retrieved. In case of any disagreement, a third author was contacted to reach an agreement (Y.Y.G.-G.).

A data extraction form was designed and constructed following the PECOS framework to obtain relevant information from the included studies. The form included population characteristics (ie, population characteristics, age, sex, socioeconomic or demographic characteristics); study design and setting characteristics (eg, city, Mexican state, recruitment location); exposure (ie, BMI, BMI categorization, and references);

outcomes: anxiety or depression outcomes and the scale used to measure such outcomes.

Risk of bias and quality assessment

The JBI (formerly the Joanna Briggs Institute) critical appraisal tool for cross-sectional studies was used to assess the quality of the included studies.²⁴ The tool evaluates 8 key methodological items (eg, inclusion and exclusion criteria; validity and reliability of measurement used; confounding factors and strategies to deal with them). "High quality" studies were those that provided sufficient detail for all items evaluated. "Unclear quality" studies had 1 or more "unclear" appreciation in the items. "Low quality" studies failed to report 1 or more items. Two reviewers (N.L.G.-F. and M.A.-M.) performed this evaluation independently and agreed on the results. A third reviewer was consulted (Y.Y.G.-G.) if there was any disagreement.

Data synthesis

A narrative synthesis was conducted because of the heterogeneity of tools used to measure mental health outcomes across the studies and the lack of similar effect measurements. Textual descriptions of studies and reported statistical analysis were recorded and tabulated. Overall, reported outcomes presented in the studies were reported narratively. The critical appraisal of the quality of each study was also considered in the synthesis.

RESULTS

Our searches identified 1074 references, and after screening titles and abstracts of these references,²⁰ were retrieved for full-text review. From these, 16 studies (reported in 18 references),^{25–42} were included in this review (Figure 1). The included studies were implemented in 12 of 32 states in Mexico (Figure 2), and 1 included a national representative sample.⁴² In these studies, participants were interviewed at a household level, whereas 9 studies recruited participants in a school setting and 6 in a clinical setting.^{25,26,30,33,34} All the included studies had a cross-sectional design.

The number of participants ranged from 60 to 5670, totaling 12 103 participants across the 16 studies. The age of the population ranged from 8 to 18 years. All studies included male and female participants, except 1, which only included female participants.²⁸ Most studies included children with different BMI categories (overall, 43.8% average prevalence of obesity), but 2 studies included only participants with obesity (Table 2^{25–42}).^{31,36}

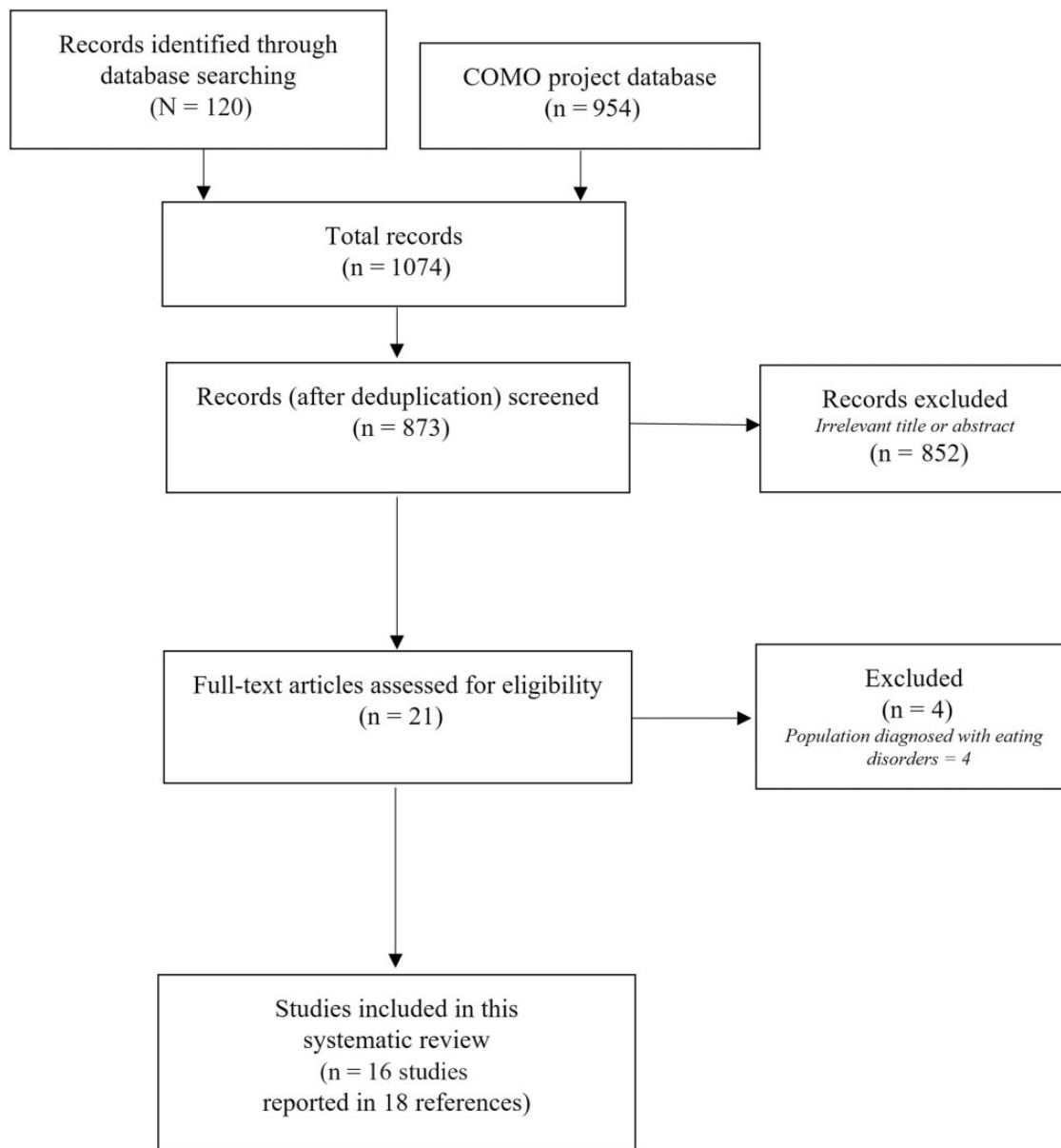


Figure 1 PRISMA flowchart. Abbreviation: COMO, Childhood and Adolescent Obesity in Mexico: Evidence, Challenges, and Opportunities.

Of all the included studies, 3^{25,29,41} focused on anxiety outcomes, 10^{26–28,30,32–36,42} focused on depression outcomes, and the rest^{31,37–40} focused on both (ie, anxiety and depression analysis).

Of those studies measuring anxiety, 3 used the Child Manifest Anxiety Scale-Revised,^{29,31,37} 2 used the Hamilton Anxiety Questionnaire,^{40,41} and 1 used a “test towards anxiety in the presence of food.”²⁵ All the tools were reported as validated in the Mexican population, Latin infant population, or adolescents in general. Although some studies used the same measurement tools, these were used (or results were presented) heterogeneously (Table 2). Overall, 1 study²⁵ found a significant positive association between nutritional status and anxiety levels ($P=0.01$). One other³⁷ reported that

participants with overweight or obesity had more likelihood (odds ratio [OR], 1.8) of presenting high anxiety levels, but no statistical test was presented to support this result. The rest of the studies did not find a significant association between anxiety and nutritional status ($P > 0.05$) (Table 2).

Some studies analyzed the presence of anxiety, along with other potential confounding factors. For instance, 2 studies^{37,39} analyzed this association by sex. The researchers found that female participants had a higher likelihood (OR, 1.4; $P < 0.001$) of manifesting anxiety or having higher levels of anxiety ($P < 0.01$) compared with male participants.^{37,41} However, it was unclear if the BMI of participants in both studies affected the association. One study²⁵ found a significant

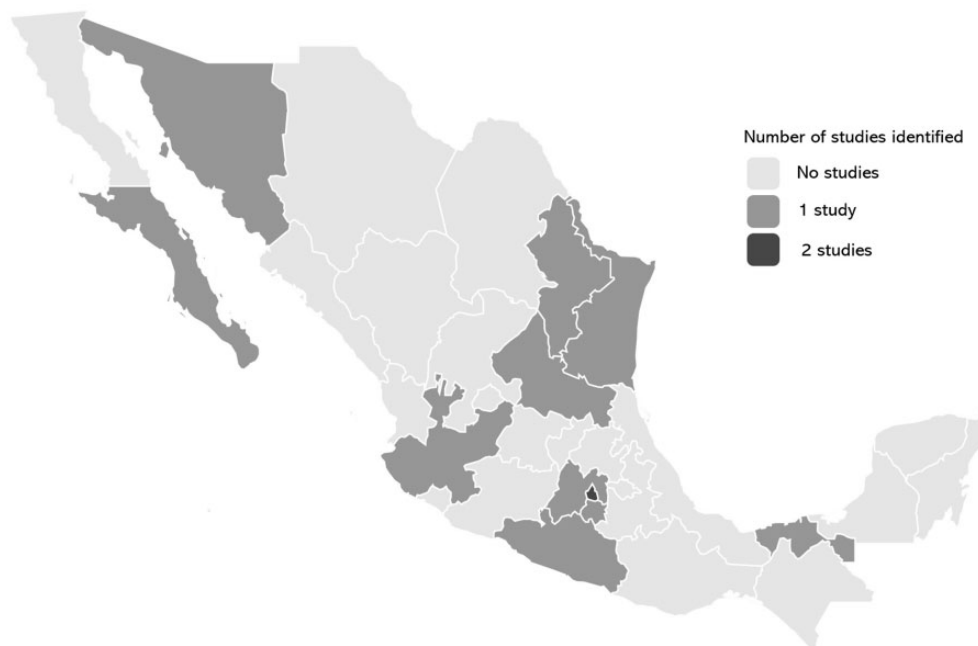


Figure 2 Map of the evidence.

association ($P < 0.05$) between anxiety and socioeconomic level. Also, the associations between anxiety and obesity varied according to the anthropometric variable used. For instance, 1 study²⁹ found an association between greater waist circumference and anxiety ($P = 0.015$), but not BMI. Additionally, 1 study³¹ found a significant association ($P < 0.05$) between higher anxiety levels among those children with overweight and obesity who reported eating less fruit.

Of those studies that measured depression, the measurement tools also varied across studies. For instance, 3 studies^{27,28,42} used the Center for Epidemiologic Studies Depression Scale in its original or shorter (10 or 7 items, respectively) version; 2^{31,38} used the Depression Scale for Children, 1³⁴ used the Depression Inventory for Children, 1³⁵ used the Zung Scale, 1³⁶ used Beck's depression inventory, and 1³⁹ used the Depression Hamilton Anxiety Questionnaire Scale. All these tools were reported as validated among children and adolescents.

In 6 studies, the prevalence of depression was higher among children or adolescents with greater BMIs.^{30,32–35,38,42} It was reported that children with overweight or obesity were up to 4.5 times (OR, 4.5; 95%CI, 1.3–14.8; $P > 0.008$) more likely to report depression.³³ Two studies reported that depression increased when BMI was higher, but such trends were not statistically significant.²⁶ Females reported significantly higher rates of depression compared with males across different studies.^{27,32,33,35,36,38,42} One study²⁷ found a significant association between BMI and depression only in female participants ($P < 0.05$) and also

reported a significant negative association between family support and depression ($P < 0.05$). Another study³¹ found an association between higher levels of depression and greater amounts of fat consumption in children with overweight and obesity ($P < 0.05$). One study³⁰ found no significant association between obesity (estimated through the BMI of participants) and depression. Nonetheless, those participants with a larger waist circumference (>90 th percentile) were significantly more likely to have depression (OR, 4.4; 95%CI, 1.4–19.5).

Quality of the included studies Most of the studies were of low ($n = 10$ of 16) or unclear ($n = 1$ of 16) quality, and only 4^{30,32,37,42} had a higher quality. Overall, some studies ($n = 5$ of 16)^{25,31,35,36} did not clearly define the criteria to include participants in the study, and in 1 study,³⁹ the inclusion criteria were unclear. All studies but 4¹ described the study participants and setting in detail.⁴¹ Most of the studies used reliable and valid tools to measure the exposure (ie, nutritional status) or the outcomes (ie, anxiety or depression). However, the identification and strategies to deal with confounding factors in the analysis were unclear in 5 studies.^{26,28,29,34,39} Finally, the statistical analysis was unclear in 3 studies^{26,34,39} (Table 3^{25–42}).

DISCUSSION

Overall, we identified 16 studies (presented in 18 references) analyzing the association between obesity and anxiety and/or depression in Mexican children and

Table 2 General characteristics of included studies

Reference and study design	Setting ^a	Participants: total (% female); age (mean [SD], y)	Prevalence of OW or OB; reference used	Outcome measurement	Overall result
Álvarez-Villaseñor 2020 ²⁵ Cross-sectional	La Paz, Baja California Sur Clinical setting	406 (50.7); age: 10.4 (1.2)	OW: 24.6, OB: 18.7, OW+OB: 43.3; CDC	Anxiety measured through a validated test toward anxiety in the presence of food (validated in Latin population)	Significative association between nutritional status with anxiety ($P = 0.01$). Also, there was a significant association between anxiety with socioeconomic level ($P = 0.01$), remaining unclear in this relationship.
Angulo-Valenzuela 2016 ²⁶ Cross-sectional	Zapopan, Jalisco Clinical setting	74 (52.7); age: 13 (NR)	OW: NA, OB: 100, OW+OB: NA; WHO	Depression measured with Birleson Scale	40.5% of the sample had depression. The level of depression increased when the BMI was higher, but this trend was not significant ($P = 0.393$)
Caetano-Anolles 2013 ²⁷ Cross-sectional	NR, San Luis Potosí School setting	102 (52.94); age: 18 (1.5)	OW: 15.7, OB: 11.8, OW+OB: 27.5; WHO	Depression measured with CESD-10 (validated)	No significant association between BMI and depression ($P > 0.05$) was found. However, when related to sex, there was a marginally significant association between BMI and depression among female participants ($P < 0.05$). There was also a significant negative association between family support and depression ($P < 0.05$) that was more significantly pronounced among female participants ($P < 0.05$).
Contreras-Valdez 2015 ²⁸ Cross-sectional	Mexico City School setting	231 (100%); age: 11.3 (0.72)	OW: 24.7, OB: 16.9, OW+OB: 41.6; WHO	Depression measured with CESD (validated)	No significant differences among the level of depression and BMI groups ($P = 0.68$). However, girls with overweight and obesity and with body dissatisfaction had lower self-esteem levels ($P < 0.01$) compared with other BMI groups. Overall, participants with obesity and overweight showed a greater body dissatisfaction level than normal-weight participants ($P < 0.01$, $P = 0.04$, respectively).
Escalante-Izeta 2016 ²⁹ Cross-sectional	Toluca, Estado de Mexico School setting	585 (49.23%); age: 9 (1.32)	OW: 29.7, OB: 26.0, OW+OB: 55.7; WHO	Anxiety measured with CMAS-R (validated)	No significant association between anxiety and BMI status ($P > 0.05$). However, there was a positive and significant association between waist size and anxiety ($P = 0.015$).
Flores 2015 ³⁰ Cross-sectional	Cuernavaca, Morelos Clinical setting	164 (49); age: 14.7 (2.3)	OW: 38.4, OB: 40.2, OW+OB: 78.5; WHO	Depressive symptoms were assessed with Children's Depression Inventory: Short Version	Overall, participants with obesity were significantly ($P < 0.05$) more likely to have depressive symptoms, and as BMI increased, more depressive symptoms were reported ($P = 0.04$). The adjusted odds for those participants with overweight and obesity were 1.9 (95%CI 0.6–6.4) and 2.7 (95%CI 0.9–9.2) to be more likely to have depression; however, these were not significant. Nevertheless, those participants with a greater waist circumference (>90th percentile) were significantly more likely to have depression OR 4.4 (95%CI 1.4–19.5).
Garcia-Falconi 2016 ³¹ Cross-sectional	Cárdenas, Centro, Macuspana, Emiliano	332 (46.1); age: NR	OW: NR, OB: NR, OW+OB: 100.0; NR	Anxiety measured with CMAS-R (validated)	No association between anxiety and BMI was found. However, authors reported that children with

(continued)

Table 2 Continued

Reference and study design	Setting ^a	Participants: total (% female); age (mean [SD], y)	Prevalence of OW or OB; reference used	Outcome measurement	Overall result
	Zapata and Tacotalpa, Tabasco School setting			Depression measured with CDS (validated)	overweight and obesity with low anxiety levels consumed fewer fruits than those with moderate anxiety ($P < 0.05$). No results were presented for depression, but when related to food consumption, authors reported that children with overweight and obesity with higher levels of depression had a higher consumption of fats ($P < 0.05$).
Gonzalez-Toche 2017 ³² Cross-sectional	Morelia, Michoacan Clinical Setting	165 (55.2); age: NR	OW: 38.4, OB: 40.2, OW+OB: 78.5; CDC	Depression measured with CDI (validated)	20.6% of the participants had depression, and a significantly higher proportion of these had obesity (64.7; $P = 0.001$); 35.3% had average weight. Also, the prevalence of depression was significantly ($P < 0.001$) higher among females (70.5%) than males (26.5%). Those participants with obesity were more likely to report depression (OR, 2.4; 95%CI, 1.1–5.3; $P = 0.025$), and that likelihood was higher among females ($r = 2.5$; 95%CI, 1.1–5.6; $P = 0.021$)
Hernández Nava 2020 ³³ Cross-sectional	Acapulco de Juárez, Guerrero Clinical setting	238 (50%); age: 10.8 (NR)	OW: NR, OB: NR, OW+OB: 37.8; WHO	Depression measured with CDI (validated)	5.9% of the sample had depression. The prevalence was higher among females (7.5%) than males (4.2%). Having overweight or obesity was associated with a higher likelihood of depression (OR, 4.5; 95%CI, 1.3–14.8; $P > 0.008$)
Lopez-Morales 2014 ³⁴ Cross-sectional	Villa Juárez, Sonora Clinical setting	101 (60.4); age: 9.89 (NR)	OW: 21.8, OB: 23.8, OW+OB: 45.5; CDC	Depression measured with CDI (validated)	28.7% of the sample had depression; of these, 65.5% of children had overweight or obesity (P value not reported).
Merino-Zeferino 2018 ³⁵ Cross-sectional	NR, Estado de México School setting	616 (50.33); age: 14 (NR)	OW: NR, OB: NR, OW+OB: 37.8; WHO	Depression measured with Zung Scale (validated)	BMI, self perception of body image, and waist size were higher in adolescents with higher depressive symptoms ($P < 0.05$). Frequency of depressive symptoms was greater in girls but unclearly related to BMI (P value not reported). There was a positive association between BMI and self perception of body image ($P = 0.0001$).
Moreno-Martínez 2018 ³⁶ Cross-sectional	Matamoros, Tamaulipas School setting	60 (65%); age: NR. School children	OW: NA, OB : 100, OW+OB: NA; WHO	Depression measured with Beck's tool (validated)	A nonsignificant relationship between depression and obesity was found ($P = 0.572$). However, female participants reported depression more frequently than males, but a relationship to BMI was unclear (P value not reported).
Pompa-Guajardo 2017 ³⁷ (Linked to Pena 2017) ³⁸ Cross-sectional	Monterrey, Nuevo León School setting	849 (53.7); age: 13.17 (NR)	OW: 29.7, OB: 28.6, OW+OB: 58.3; WHO	Anxiety measured with CMAS-R (validated) Depression measured with CDS (validated)	A person with overweight or obesity has an OR of 1.8 of presenting with high stress and anxiety levels (P value and CIs not reported). Females had a higher likelihood of manifesting anxiety than males, but this

(continued)

Table 2 Continued

Reference and study design	Setting ^a	Participants: total (% female); age (mean [SD], y)	Prevalence of OW or OB; reference used	Outcome measurement	Overall result
Radilla 2013 ^{39,40} (abstracts) Cross-sectional	Mexico City School setting	142 (50.7); age: NR School children	OW: 27.5, OB: 13.4, OW+OB: 40.9; WHO	Anxiety and depression measured with HAD (validated)	was not related to BMI (OR, 1.4; 95%CI, 0.955–2.032; $P > 0.001$). The prevalence of depression in participants with overweight or obesity was 57.9% compared with 42.1% of participants with normal weight. There was no statistically significant association between variables (OR, 0.976, 95%CI, 0.733–1.298; $P > 0.005$). The percentage of depressive symptoms was higher among female adolescents and even higher among those with overweight or obesity compared with boys and those with normal weight ($P > 0.005$). No significant association was found between anxiety and nutritional status ($P > 0.05$), as well as between depression and nutritional status ($P > 0.05$).
Radilla-Vazquez 2015 ⁴¹ Cross-sectional	Mexico City School setting	2368 (49.75); age: 12.1 (0.5)	OW: NR, OB: NR, OW+OB: NR; WHO	Anxiety and measured with HAD (validated)	No significant association was found between anxiety and nutritional status ($P > 0.05$). Girls had higher anxiety levels ($P < 0.01$) than boys. However, it is unclear if there was a relation with their BMI. Children attending school in the evening had higher anxiety than in those attending during the morning ($P < 0.05$).
Shamah-Levy 2020 ⁴² Cross-sectional (ENSANUT 2018-19)	National Sample Home setting	5670 adolescents (49.8); age: 15.3 (NR)	OW: 23.8, OB: 14.7, OW+OB: 38.5; WHO	Depression symptoms were measured with CESD-7 (validated)	3.5% of the sample had depression. The likelihood of depression increased with obesity (OR, 1.46; $P = 0.035$) and was reported to be greater in females (OR, 2.07; $P < 0.001$) and to increase with age (OR, 1.21; $P < 0.001$). In addition, the probability of having depression was reported to be greater than the medium wellness index (based on household conditions) (OR, 1.59; $P = 0.006$), although it seemed to be greater in the high wellness index, but not significantly so (OR, 1.39; $P = 0.071$) (both compared with the lower wellness index).

^aCity or municipality, state in Mexico.

Abbreviations: BMI, body mass index; CDC, Centers for Disease Control and Prevention; CDI, Depression Inventory for Children; CDS, Depression Scale for Children; CES-D, Center for Epidemiologic Studies Depression Scale (CESD-7 is the short version); CMAS-R, Child Manifest Anxiety Scale-Revised; ENSANUT, Mexican National Health and Nutrition Survey; HAD, Hamilton Anxiety Questionnaire; NA, not applicable; NR, not reported; OB, obesity; OW, overweight; WHO, World Health Organization.

Table 3 The JBI critical appraisal tool: quality appreciation

Reference	Criteria for inclusion in the sample clearly defined	Study participants and the setting described in detail	Exposure measured in a valid and reliable way	Standard criteria used for measurement of the condition	Confounding factors identified	Strategies to deal with confounding factors stated	Outcomes measured in a valid and reliable way	Appropriate statistical analysis used	Overall critical appraisal
Álvarez-Villaseñor 2020 ²⁵	×	✓	✓	✓	✓	✓	?	✓	Low
Angulo-Valenzuela 2016 ²⁶	✓	✓	✓	✓	×	×	✓	?	Low
Caetano-Anolles 2013 ²⁷	×	✓	?	✓	✓	✓	✓	✓	Low
Contreras-Valdez 2015 ²⁸	✓	✓	✓	✓	×	×	✓	✓	Low
Escalante-Izeta 2016 ²³	✓	✓	✓	✓	×	?	✓	✓	Low
Flores 2015 ³⁰	✓	✓	✓	✓	✓	✓	✓	✓	High
García-Falconi 2016 ³¹	×	✓	?	?	✓	✓	✓	✓	Low
González-Toche 2017 ³²	✓	✓	✓	✓	✓	✓	✓	✓	High
Hernández-Nava 2020 ³³	✓	✓	✓	✓	✓	?	✓	✓	High
Lopez-Morales 2014 ³⁴	✓	✓	✓	✓	✓	?	✓	✓	Unclear
Merino-Zeferino 2018 ³⁵	×	✓	✓	✓	×	×	✓	?	Low
Moreno-Martínez 2018 ³⁶	×	✓	?	✓	✓	✓	✓	✓	Low
Pompa-Guajardo 2017 ³⁷ and Pena 2017 ³⁸	✓	✓	✓	✓	✓	✓	✓	✓	Low
Radilla 2013 ^{39,40} (abstracts)	?	✓	?	?	?	×	?	?	High
Radilla-Vazquez 2015 ⁴¹	✓	×	?	?	✓	✓	?	?	Low
Shamah-Levy 2020 ⁴²	✓	✓	✓	✓	✓	✓	✓	✓	High

Key: ✓, yes; ×, no; ?, unclear.

adolescents. Of all the included studies, 3^{25,29,41} focused on anxiety outcomes, 10^{26–28,30,32–36,42} on depression outcomes, and the rest^{31,37–40} focused on both (ie, anxiety and depression analysis). The minority of the studies (25%) were considered high quality. Although the evidence is unclear on the association of obesity with anxiety, most evidence suggests that Mexican children and adolescents with higher BMIs (or other anthropometric measurements suggesting obesity) are more likely to present depression or higher depressive symptoms than those with a normal weight. Such likelihood is greater for females with higher BMIs than for males. In addition, evidence from Mexico suggests that such an association can be influenced by other sociodemographic factors, socioeconomic status, family support, and lifestyles (eg, dietary).

The associations between obesity and depression have been found in cross-sectional and longitudinal research.⁴³ However, longitudinal studies are essential to quantify the bidirectional relationship between obesity and depression.^{6,16} Previous results have shown that cross-sectional studies identify associations between childhood obesity and depression or anxiety more frequently than longitudinal studies.⁶ Unfortunately, no longitudinal studies were identified among Mexican children and adolescents regarding obesity and mental health issues. Hence, the bidirectionality of this association was not evaluated among the Mexican pediatric population. Nonetheless, evidence from high-income countries has suggested a 70% increased risk of obesity among adolescents with depression. Conversely, adolescents with obesity had a 40% greater risk of having depression.¹⁶

Several possible mechanisms have been hypothesized to be implicated in the etiology of obesity and depression and their bidirectional association. For instance, a shared genetic or biological mechanism including inflammation,^{44,45} neuroendocrine mechanisms,⁴⁶ or dysregulation of the hypothalamic-pituitary-adrenocortical axis has been suggested.⁴⁷ Lifestyles might also be linked to obesity and depression, especially among young people, whereby changes in appetite and dietary patterns might result in altered weight, sedentary activity, or sleeping.¹⁶ Some dietary patterns (eg, overconsumption of savory food, usually high in fat, salt, or sugar) have been associated with depression and are also linked to obesity.⁴⁸ However, there is also evidence suggesting that depressive symptoms might be associated with a reduced likelihood of eating a healthy diet among Latino populations.⁴⁹

In Mexico, it has been documented that emotional and behavioral difficulties among children are linked to soda consumption.⁵⁰ Emotional and behavioral difficulties are also linked to sleep problems in children and

adolescents,⁵¹ and a poor sleeping quality is also associated with greater amount of soda consumption. This dietary behavior could lead to obesity.⁵⁰ In this same line, other emotional and behavioral difficulties (eg, binge eating, lower self-esteem, altered self-concept) have also been strongly correlated with BMI among a pediatric population.^{52,53} Nevertheless, several emotional short- and long-term emotional tolls have also been reported among children and adolescents with obesity (eg, stigmatization, bullying, mood disorders, altered self-esteem and self-image).⁵⁴

A recent review of the COMO project reported that Mexican children and adolescents with obesity are highly exposed to stigmatization by peers and even family members.²¹ Such stigmatization might also lead to depression or anxiety,⁵⁵ affecting their general well-being and other outcomes (eg, school performance),⁵⁶ although, it has also been described that stigmatization, depressive symptoms, lack of physical appearance, and low self-esteem in adolescents with obesity entailed greater than average weight gain.⁵⁷ However, it is still unclear whether higher BMIs entail high depression scores because of stigmatization, bullying, lower self-esteem, or other psychological mediators.⁶

The results of this review suggest that females are more vulnerable to depression and anxiety, especially if their BMIs are higher. Such a result aligns with previous international evidence suggesting that adolescent females with obesity are more likely to develop depression or report a higher number of depressive symptoms than normal-weight adolescents or males.^{6,14–16,57,58} This is relevant considering that obesity seems to be distinguished as an issue in Mexican culture only in females by children, adolescents, or even family members.²¹ Overall, there is consistent evidence for a sex effect in bidirectional associations of obesity and depression with a stronger relationship in females than males.⁶ Body satisfaction has been suggested to be a key factor when considering sex in this association.⁴ Obesity has been related to body dissatisfaction and decreased self-esteem, which both are considered risk factors for depression.⁴⁵ Females might be more susceptible to present body dissatisfaction or be more aware of weight-related issues than males. One of the included studies²⁸ found that females with overweight and obesity had significantly greater body dissatisfaction and lower self-esteem levels than normal-weight adolescents. The perception of being overweight might also increase psychological distress because of beauty or thinness ideals among females. Evidence from longitudinal studies conducted in high-income countries suggested that the longer a female child or adolescent has obesity or depression, the more likely it is that lifestyle

and environmental factors may enhance this association.^{59,60}

Almost none of the current interventions to treat¹⁷ or prevent¹⁸ obesity among Mexican children and adolescents contemplates mental health outcomes. Romero et al⁶¹ implemented a randomized controlled trial to measure the effectiveness of a physical activity program over anthropometric indicators and levels of anxiety and depression in Mexican school-aged children with obesity. The experimental group received 2 weekly 50-minute sessions for 20 consecutive weeks. Overall, the researchers found that the physical exercise program favored the appearance of positive thoughts, with improvements in the participants' emotional well-being, self-perception, and self-concept. However, it did not produce significant weight changes, height, Z-score, level of anxiety, or depressive thoughts.⁶¹ Such intervention was evaluated in the short term (<12 mo); hence, longer interventions and evaluations are needed to estimate the effect on anthropometric and mental health outcomes.

The findings in this review need to be interpreted in light of its limitations and strengths. One of the main limitations of this study was the limited number of high-quality studies and the high heterogeneity of the included studies. For example, included studies used various scales and tools to measure anxiety or depression. Also, studies varied in their methods and analysis, thus hindering a solid comparison. Hence, effect measurements made unfeasible a more consistent synthesis or quantitative analysis (ie, meta-analysis). There was also a variation in the obesity diagnosis, influencing the results. Moreover, retrieved evidence came from 12 of 32 states in Mexico and mainly from urban areas. Consequently, the results might not show a nationwide picture and overlook vulnerable populations. Finally, not all the included studies reported thoughtfully socio-demographic or economic characteristics of the participants, which might also affect both depression and obesity.

This work's strengths include an extensive and comprehensive search for evidence, performed in 2 languages, which helped us capture relevant publications. In addition, an extensive search for grey literature was conducted as part of the COMO project.¹⁹ However, no related information about mental health (including depression or anxiety) was identified among Mexican children or adolescents.

Current efforts to treat¹⁷ or prevent¹⁸ obesity in Mexico focus on weight-related outcomes only, overlooking the impact such interventions could have on mental health outcomes. Evidence suggests that a multi-component and multidisciplinary intervention that includes dietary modifications, physical activity

practice, psychological accompaniment (eg, cognitive behavioral therapy), and active parental involvement can effectively tackle obesity among Mexican children.¹⁷ Similar approaches are also recommended for treating anxiety^{62,63} or depression among children and adolescents.⁶³ Likewise, it has been reported that children with obesity are more likely to have mental health issues and complicate obesity treatment or prevention efforts. Hence, obesity and mental health treatment strategies share many common elements. Therefore, various strategies are needed within an intervention to influence both obesity and mental health issues.⁶⁴

Obesity and mental health problems have health and well-being implications in the short and long term, and they can carry both until adulthood. Although obesity, anxiety, and depression are associated with a child's negative performance and risky lifestyles in the short and long term, these conditions tend to be chronic and recurring.⁶⁵ Furthermore, health promotion and prevention should address common risk factors and broader risk social determinants shared between noncommunicable diseases.

CONCLUSION

In Mexico, children and adolescents with obesity are more likely to report depression or depressive symptoms. Such likelihood is greater and more evident for females. Unfortunately, the lack of longitudinal data and high-quality studies makes it difficult to establish causation or the bidirectionality of the association between conditions (ie, obesity and mental health issues), and no accurate conclusion can be drawn. Nevertheless, both conditions are highly prevalent among Mexican children and adolescents. Moreover, obesity and mental health issues treatment and prevention strategies share many common elements that can be considered in future health promotion interventions.

Acknowledgements

Author contributions. M.A.-M. and C.F.M.G. conceptualized and currently lead the COMO project. N.L.G.-F., Y.Y.G.-G., L.L.-C., M.G.-B., C.F.M.-G., and M.A.-M. contributed significantly to the data collection, data interpretation, and analysis; took part in the critical writing and revision of the article; and read and approved the versions submitted to the journal.

Funding. No funding was received to do this work. M.A.-M. is currently funded by the Scottish Government's Rural and Environment Science and Analytical Services Division.

Declaration of interest. Y.Y.G.-G. received funding from Bonafont for a presentation at a congress in 2016 and funding from Abbott to write 2 book chapters in 2020. The other authors have no relevant interests to declare.

Supporting Information

The following [Supporting Information](#) is available through the online version of this article at the publisher's website.

PRISMA 2020 checklist

[Supplemental Material 1. Search strategy for Medline and Embase](#)

REFERENCES

- Charlson F, van Ommeren M, Flaxman A, et al. New WHO prevalence estimates of mental disorders in conflict settings: a systematic review and meta-analysis. *Lancet*. 2019;394:240–248.
- Garber J, Brunwasser SM, Zerr AA, et al. Treatment and prevention of depression and anxiety in youth: test of cross-over effects. *Depress Anxiety*. 2016;33:939–959.
- Hetrick SE, Cox GR, Witt KG, et al.; Cochrane Common Mental Disorders Group. Cognitive behavioural therapy (CBT), third-wave CBT and interpersonal therapy (IPT) based interventions for preventing depression in children and adolescents. *Cochrane Database Syst Rev*. 2016;2016.
- Sutaria S, Devakumar D, Yasuda SS, et al. Is obesity associated with depression in children? Systematic review and meta-analysis. *Arch Dis Child*. 2019;104:64–74.
- Weihrauch-Blüher S, Wiegand S. Risk factors and implications of childhood obesity. *Curr Obes Rep*. 2018;7:254–259.
- Mühlig Y, Antel J, Föcker M, et al. Are bidirectional associations of obesity and depression already apparent in childhood and adolescence as based on high-quality studies? A systematic review. *Obesity Rev*. 2016;17:235–249.
- Reeves GM, Postolache TT, Snitker S. Childhood obesity and depression: connection between these growing problems in growing children. *Int J Child Health Hum Dev*. 2008;1:103–114.
- Lindberg L, Hagman E, Danielsson P, et al. Anxiety and depression in children and adolescents with obesity: a nationwide study in Sweden. *BMC Med*. 2020;18:30.
- Encuesta Nacional de Salud y Nutrición (ENSANUT) 2018. Instituto Nacional de Estadística y Geografía (INEGI); July 2019. 2018. Available at: https://ensanut.insp.mx/encuestas/ensanut2018/doctos/informes/ensanut_2018_presentacion_resultados.pdf. Accessed March 1, 2022.
- Aceves-Martins M, Llauradó E, Tarro L, et al. Obesity-promoting factors in Mexican children and adolescents: challenges and opportunities. *Glob Health Action*. 2016;9:29625.
- Benjet C, Borges G, Medina-Mora ME, et al. Youth mental health in a populous city of the developing world: results from the Mexican Adolescent Mental Health Survey. *J Child Psychol Psychiatry*. 2009;50:386–395.
- Whitaker BN, Fisher PL, Jambhekar S, et al. Impact of degree of obesity on sleep, quality of life, and depression in youth. *J Pediatr Health Care*. 2018;32:e37–e44.
- Morrison KM, Shin S, Tamopolsky M, et al. Association of depression & health related quality of life with body composition in children and youth with obesity. *J Affect Disord*. 2015;172:18–23.
- Rao W-W, Zong Q-Q, Zhang J-W, et al. Obesity increases the risk of depression in children and adolescents: results from a systematic review and meta-analysis. *J Affect Disord*. 2020;267:78–85.
- Hoare E, Skouteris H, Fuller-Tyszkiewicz M, et al. Associations between obesogenic risk factors and depression among adolescents: a systematic review. *Obes Rev*. 2014;15:40–51.
- Mannan M, Mamun A, Doi S, et al. Prospective associations between depression and obesity for adolescent males and females: a systematic review and meta-analysis of longitudinal studies. *PLoS One*. 2016;11:e0157240.
- Aceves-Martins M, López-Cruz L, García-Botello M, et al. Interventions to treat obesity in Mexican children and adolescents: systematic review and meta-analysis. *Nutr Rev*. 2022;80:544–560.
- Aceves-Martins M, López-Cruz L, García-Botello M, et al. Interventions to prevent obesity in Mexican children and adolescents: systematic review. *Prev Sci*. 2022;23:563–586.

19. Aceves-Martins M, Childhood and adolescent Obesity in Mexico: Evidence, challenges and opportunities (COMO) Project. Available at: <https://www.comoprojectmx.com/>. Accessed February 15, 2022.
20. Aceves-Martins M, Godina-Flores NL, Gutierrez-Gómez YY, et al. Obesity and oral health in Mexican children and adolescents: systematic review and meta-analysis. *Nutr Rev*. 2022;80:544–560.
21. Aceves-Martins M, López-Cruz L, García-Botello M, et al. Cultural factors related to childhood and adolescent obesity in Mexico: a systematic review of qualitative studies. *Obes Rev*. 2022;23:e13461.
22. Centre for Reviews and Dissemination, University of York. International prospective register of systematic reviews (PROSPERO). Centre for Reviews and Dissemination, University of York. 2021. Available at: <https://www.crd.york.ac.uk/prospero/>. Accessed February 2, 2020.
23. Shamseer L, Moher D, Clarke M, et al; the PRISMA-P Group. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. *BMJ* 2015;349:g7647.
24. Joanna Briggs Institute. The Joanna Briggs Institute Critical Appraisal tools for use in JBI Systematic Reviews. Checklist for Analytical Cross Sectional Studies. 2017. Available at: https://jbi.global/sites/default/files/2019-05/JBI_Critical_Appraisal-Checklist_for_Analytical_Cross_Sectional_Studies2017_0.pdf. Accessed February 15, 2022.
25. Álvarez-Villasenor AS, Osuna UF, Barrera JS, et al. Anxiety in the presence of food in schoolchildren of Baja California Sur. *Nutr Hosp*. 2020;37:692–697.
26. Angulo-Valenzuela RA, Delgado-Quinones EG, Urióstegui-Espíritu LC, et al. Prevalencia de depresión y dislipidemia en un grupo de adolescentes obesos Mexicanos. *Atención Familiar*. 2016;23:53–56.
27. Caetano-Anolles KT-G, Raffaelli M, Sanchez BA, et al. Depression, family support, and body mass index in Mexican adolescents. *Rev Interam Psicol* 2013;47:139–146.
28. Contreras-Valdez JA, Hernández-Guzmán L, Freyre M-Á. Body dissatisfaction, self-esteem, and depression in girls with obesity. *Rev Mex de Trastor Aliment*. 2016;7:24–31.
29. Escalante-Izeta EI, Haul-Navarro K, Moreno-Landa LI, et al; Departamento de Salud, Universidad Iberoamericana, Ciudad de México. Variables nutricias asociadas con la ansiedad y la autopercepción corporal en niñas y niños mexicanos de acuerdo con la presencia de sobrepeso/obesidad. *Salud Mental*. 2016;39:157–163.
30. Flores YN, Shaibi GQ, Morales LS, et al. Perceived health status and cardiometabolic risk among a sample of youth in Mexico. *Qual Life Res*. 2015;24:1887–1897.
31. García-Falconi RA, Sanchez JE, Barjau HG, et al. Ansiedad, depresión, hábitos alimentarios y actividad en niños con sobrepeso y obesidad. *Horizonte Sanitario*. 2016;15:91–97.
32. González-Toche J, Gómez-García A, Gómez-Alonso C, et al. Association between obesity and childhood depression in school children of a family medicine unit in Morelia. *Michoacán Atención Familiar*. 2017;24:8–12.
33. Nava JPH, Morales BJ, Morales GJ, et al. Depresión y factores asociados en niños y adolescentes de 7 a 14 años de edad. *Atención Familiar*. 2020;27:38–42.
34. López-Morales CP-O, Gonzalez-Heredia R, Brito-Zurita OR, et al. Depresión y estado de nutrición en escolares de Sonora. *Rev Méd Inst Mex Seguro Soc*. 2014;52:S64–7.
35. Merino-Zeferino BG-V, Márquez-González H, Guameros-Soto N, et al. Asociación de síntomas depresivos por tamizaje con el estado nutricional y autopercepción de la imagen corporal en un grupo de adolescentes del estado de México. *Rev Mex Endocrinol Metabol Nutr*. 2018;5:5–12.
36. Moreno Martínez MA, Martínez Aguilar MD, Ávila Alpírez H, et al. Relación entre obesidad y depresión en adolescentes. *Cult de los Cuidados* 2018;22:154–159.
37. Pompa Guajardo EG, Meza Peña C. Ansiedad, estrés y obesidad en una muestra de adolescentes de México. *Univ Psychol*. 2017;16:1.
38. Peña CM, Guajardo EGP. An approach to the study of obesity and depression in a sample of mexican adolescents in northern Mexico Cecilia Meza Peña. *Cienc Ergo Sum*. 2018;25:1–9.
39. Radilla C, Vega S, Gutierrez R, et al. Relation between the depression and the nutritious condition in adolescents of middle schools in Mexico City. *Ann Nutr Metabol* 2013;63:674–674.
40. Radilla CV, Gutierrez R, Radilla M, et al. Association of the anxiety with the nutritious condition in adolescents, ages 11 to 13 years in Mexico City: PO283. *Ann Nutr Metabol* 2013.
41. Vázquez CCR, Vega S, Tolentino RG, et al. Prevalencia de conductas alimentarias de Riesgo y su asociación con ansiedad y estado nutricional en adolescentes de escuelas secundarias técnicas del Distrito Federal, México. *Revista Española de Nutrición Comunitaria— Spanish Journal of Community Nutrition* 2015;21:15–21.
42. Shamah-Levy T, Cuevas-Nasu L, Humarán IM-G, et al. Prevalencia y predisposición a la obesidad en una muestra nacional de niños y adolescentes en México. *Salud Publica Mex*. 2020;62:725–733.
43. Vittengl JR. Mediation of the bidirectional relations between obesity and depression among women. *Psychiatry Res*. 2018;264:254–259.
44. Kivimäki M, Shipley MJ, Batty GD, et al. Long-term inflammation increases risk of common mental disorder: a cohort study. *Mol Psychiatry*. 2014;19:149–150.
45. Luppino FS, De Wit LM, Bouvy PF, et al. Overweight, obesity, and depression. *Arch Gen Psychiatry*. 2010;67:220.
46. Su S-C, Sun M-T, Wen M-J, et al. Brain-derived neurotrophic factor, adiponectin, and proinflammatory markers in various subtypes of depression in young men. *Int J Psychiatry Med*. 2011;42:211–226.
47. Bornstein SR, Schuppenies A, Wong ML, et al. Approaching the shared biology of obesity and depression: the stress axis as the locus of gene–environment interactions. *Mol Psychiatry*. 2006;11:892–902.
48. Quirk SE, Williams LJ, O'Neil A, et al. The association between diet quality, dietary patterns and depression in adults: a systematic review. *BMC Psychiatry*. 2013;13:175–175.
49. Pagoto SL, Ma Y, Bodenlos JS, et al. Association of depressive symptoms and lifestyle behaviors among Latinos at risk of type 2 diabetes. *J Am Diet Assoc*. 2009;109:1246–1250.
50. Wang Z, Jansen EC, Miller AL, et al. Childhood emotional and behavioral characteristics are associated with soda intake: a prospective study in Mexico City. *Pediatr Obes*. 2020;15:e12682.
51. Sadeh A, Tikotzky L, Kahn M. Sleep in infancy and childhood: implications for emotional and behavioral difficulties in adolescence and beyond. *Curr Opin Psychiatry*. 2014;27:453–459.
52. Bosch J, Stradmeijer M, Seidell J. Psychosocial characteristics of obese children/youngsters and their families: implications for preventive and curative interventions. *Patient Educ Couns*. 2004;55:353–362.
53. Pasold TL, McCracken A, Ward-Begnoche WL. Binge eating in obese adolescents: emotional and behavioral characteristics and impact on health-related quality of life. *Clin Child Psychol Psychiatry*. 2014;19:299–312.
54. Cornette RE. Chapter 24 - The Emotional Impact of Obesity on Children. In: Bagchi D, ed. *Global Perspectives on Childhood Obesity*. London, United Kingdom: Academic Press; 2011:257–264.
55. Sweeting H, Wright C, Minnis H. Psychosocial correlates of adolescent obesity, 'slimming down' and 'becoming obese'. *J Adolesc Health*. 2005;37:409.e9–409.e17.
56. Levasseur P, Ortiz-Hernandez L. Comment l'obésité infantile affecte-t-elle la réussite scolaire? Contributions d'une analyse qualitative mise en place à Mexico. [How does childhood obesity affect school achievement? Contributions from a qualitative analysis implemented in Mexico City]. *Autrepart*. 2017;83:51–72.
57. Korczak DJ, Lipman E, Morrison K, et al. Are children and adolescents with psychiatric illness at risk for increased future body weight? A systematic review. *Dev Med Child Neurol*. 2013;55:980–987.
58. Quek Y-H, Tam WWS, Zhang MWB, et al. Exploring the association between childhood and adolescent obesity and depression: a meta-analysis. *Obes Rev*. 2017;18:742–754.
59. Anderson SE, Murray DM, Johnson CC, et al. Obesity and depressed mood associations differ by race/ethnicity in adolescent girls. *Int J Pediatr Obes*. 2011;6:69–78.
60. Pine DS, Goldstein RB, Wolk S, et al. The association between childhood depression and adulthood body mass index. *Pediatrics*. 2001;107:1049–1056.
61. Romero-Pérez EM, González-Bernal JJ, Soto-Cámara R, et al. Influence of a physical exercise program in the anxiety and depression in children with obesity. *IJERPH*. 2020;17:4655.
62. Öst L-G, Ollendick TH. Brief, intensive and concentrated cognitive behavioral treatments for anxiety disorders in children: a systematic review and meta-analysis. *Behav Res Ther*. 2017;97:134–145.
63. Dale LP, Vanderloo L, Moore S, et al. Physical activity and depression, anxiety, and self-esteem in children and youth: an umbrella systematic review. *Ment Health Phys Act*. 2019;16:66–79.
64. Small L, Aplasca A. Child obesity and mental health: a complex interaction. *Child Adolesc Psychiatry Clin N Am*. 2016;25:269–282.
65. Werner-Seidler A, Perry Y, Calear AL, et al. School-based depression and anxiety prevention programs for young people: a systematic review and meta-analysis. *Clin Psychol Rev*. 2017;51:30–47.



PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	3-4
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	4
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	5-6
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	4
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Supplemental material 1
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	6
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	6
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	4-5
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	NA
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	6-7
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	7
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	7
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	7
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	7
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	NA
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	NA
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	NA
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	NA
Certainty	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	NA



PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
assessment			
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	7-10, Table 2
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	7-10
Study characteristics	17	Cite each included study and present its characteristics.	7
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Table 3
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Table 2
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Table 2 and 3
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	NA
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Table 2
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	NA
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Table 3
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	NA
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	10
	23b	Discuss any limitations of the evidence included in the review.	12-13
	23c	Discuss any limitations of the review processes used.	12-13
	23d	Discuss implications of the results for practice, policy, and future research.	13-14
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	4
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	4
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	14
Competing interests	26	Declare any competing interests of review authors.	14
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	NA



PRISMA 2020 Checklist

For more information, visit: <http://www.prisma-statement.org/>